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Professor Erland A Svensson

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University of Linkoping
Olaus Magnus vag 42
Linkoping SE-581 11
Sweden

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14. ABSTRACT: What are the implications of the structural models for leader and team adaptability? ***Emotional Stability*** and ***Adaptability*** are fundamental aspects in selection of personnel working under stressful conditions with high stakes and risks. With high emotional stability your cognitive performance (information handling and decision making) can stand high stress levels longer without deterioration. With high ability to adapt you are better at handling complex and ambiguous information and situations. We have in other modeling studies (Svensson, Angelborg-Thanderz, & Sjöberg, 1993) found that emotional cooping processes will increase and interfere with problem solving cooping processes when the challenge (the combination of risk- and complexity aspects) of a task increases. Sooner or later emotional cooping dominates with deteriorated decision making as a consequence. Emotional stability counteracts and delays emotional cooping. There are similarities between the effects of emotional stability and the effects of training – both delay emotional cooping and support problem solving cooping processes. It is not for nothing that emotional stability and intense training since long form corner stones for effective military operations.

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UNCLAS	UNCLAS	UNCLAS	UL	25	19b. TELEPHONE NUMBER *(Include area code)* +44 (0)1895 616459

Final Report (deliverable no. 4) for EOARD project "Cognitive and Personality Determinants of Cultural Adaptability", Contract no. FA8655-07-M-4012.

Predictive Modelling of Operative Performance by means of Personality Traits – Implications for Selection of Personnel

Erland Svensson

Jenny Lindoff

Martin Castor
Swedish Defence Research Agency
Sweden

Janet Sutton
U.S. Air Force Research Laboratory
Human Effectiveness Directorate
Cognitive Systems Branch
Wright-Patterson AFB, OH 45433 USA

ABSTRACT

A series of factors have impact on teamwork and performance in multinational coalitions. Individual differences in personality traits represent powerful factors that, in interaction with culturally based cognitive biases, influence collaboration and performance. The present report is based on two studies: Study One (Svensson, Lindoff, Anderson, Norlander, & Sutton, 2005; Svensson, Lindoff, & Sutton, 2008) presents data-reduction and modeling of personality measures from two occasions (Allied Warrior 2004, and 2005). In Study Two (Svensson, Lindoff, & Castor, 2009,) a model developed by Stokes, Schneider and Lyons (2008) was validated, and the relationships between personality- and performance measures were analysed in a diversified sample.

By means of factor analyses, multidimensional scaling, and modeling ad modum LISREL, 17 personality measures of Study One have been reduced to models of three interrelated factors. From initial model analyses, we found that the co-variances between variables were explained by a sequential relation between the factors Emotional Stability, Adaptability, and Need for Structure. An interpretation of the model is that if you have a high rating in Emotional Stability, your rating in Adaptability will be high as well. And, if your rating is high in Adaptability, your rating in Need for Structure is low. Analyses including a second database confirmed the proposed model. An alternative model to the sequential was proposed. In this model Emotional Stability directly affects Need for Structure and Adaptability. Confirmative analyses of the alternative model showed that this model has the same fit as the sequential. We have tested the fit of the models when using two of the main markers of each factor, and we found an almost perfect fit of the sequential as well as the alternative model. Accordingly, six of the measures used can represent the models adequately. Our conclusion is that the subjects can be ordered or classified with respect to the three factors by means of six measures. Four trait dimensions of the 'Big Five'

are markers of our factors Emotional Stability and Adaptability, and the interaction between two fundamental dimensions behind the 'Big five' is in accordance with these two factors of our models. Emotional Stability and Adaptability are fundamental aspects in selection of personnel working under stressful conditions with high stakes and risks. By mean of the factors found and validated, we have reliable and practicable measures of basic aspects predicting the performance and co-operative ability.

Unfortunately, no data on individual and team performance were available for these analyses. Accordingly, the causal relationships between Stability- and Adaptability measures and *aspects of performance could not be tested. In studies performed by Stokes et al., (2008), the effects of the dispositional traits on adaptive performance were analyzed. In these analyses, the three- factors model presented above was a starting point, to which measures of Stress-coping appraisals, measures of Self-efficacy, and measures of Adaptive Performance were added. Model analyses in these studies identified the dispositional traits of an adaptive profile, and confirmed that the effects of the profile on adaptive performance were mediated by Stress-coping and Self-efficacy. The purpose of Study Two (Svensson, et al., 2009) was to validate Stokes et al. model, and estimate the effects on the performance-related criterion variables from the personality profile, and coping processes in other situations, and with other samples of operational subject, in order to broaden the applicability of the complete model. From model analyses based on data representing different groups and situations, we confirmed the unified model even if we found the mediating effects of the proximal predictor Stress-coping to be limited. We conclude that by mean of the factors found and validated, the development of reliable and practicable measures of basic aspects predicting performance and co-operative ability of personnel working in coalition has been brought a step further.*

1.0 INTRODUCTION STUDY ONE

Individual differences in personality traits represent aspects that, in interaction with culturally based cognitive biases, we believe influence collaboration and performance. Especially personality traits reflecting aspects of emotional stability have, since long, been considered important in selection of personnel working under high psychological stress, task load and risk. Selection of e.g. military pilots by means of personality traits as well as intellectual, perceptual and motor skills was introduced as early as during World War I. Similar procedures for selection were then developed and introduced in the army and naval branches. Procedures for selection with respect to operator and team performance in command and control environments are of a later date and in progress.

Selection of military operators has been extensively discussed in the scientific literature. Several meta-analyses have shown that personality traits, in spite of their considerable face validity, have a restricted predictive power on operational performance as compared to job sample tasks. In general terms, we can conclude that personality measures have a common variance of about 10 to 20 percent with different performance criteria (Sjöberg, Källmén, & Scharnberg, 1997). The corresponding values for job sample tasks are about 30 to 40 percent (Hunter, & Burke, 1995). On the other hand, personality or trait measures are easily administered and, in many situations, the most practicable and ***the*** remaining possibility to predict and optimize operational performance. Accordingly, an optimal combination of personality and task-related measures gives the best predictive power in selection of operators.

To cite the steering program for the NATO RTO task group *Leader and Team Adaptability in Multinational Coalitions,* a "*complicated assemblage of coalition partners will be required to perform as a team in complex environments that place high demands on the command and control of forces. This complex environment makes* ***adaptive performance*** *more critical than ever, yet the presence of* ***adaptable leaders*** *and* ***teams*** *continues to be elusive*" (Pierce, 2002).

1.1 Methods, Assumptions, Procedures

1.1.1 Factor Analysis (FA)

Factor analysis is an analytical technique that makes possible the reduction of a larger number of interrelated manifest variables to a smaller number of latent variables or factors. The FA technique is based on the co-variation between manifest measured variables, and the goal of the technique is to achieve a parsimonious and simplified description by using the smallest number of explanatory concepts needed to explain the maximum amount of common variance. The factors can be considered as hypothetical constructs laying behind and explaining the co-variation between their markers, and the constructs find their manifest expression in their markers. The factor extraction procedures can be divided into *exploratory and confirmative* (hypothesis testing) methods. Explorative solutions cannot be generalised to populations. Generalisation requires replications in new samples. Factor solutions from confirmative methods of factor extraction, on the other hand, can be generalised from a sample to a population of subjects (Gorsuch, 1974; Tinsley, & Tinselly, 1987; Wilkinson, 1990; Hair, Anderson, Tatham, & Black, 1998).

1.1.2 Structural Equation Modelling (LISREL)

In the LISREL model, the linear structural relationship and the factor structure are combined into one comprehensive model applicable to observational studies. The model allows 1) multiple latent constructs indicated by observable explanatory variables, 2) recursive and non-recursive relationships between constructs, and 3) multiple latent constructs indicated by observable response variables. The connections between the latent constructs compose the structural equation model (or the structural model); the relationships between the latent constructs and their observable indicators or outcomes compose the factor models (or the measurement model). All parts of the comprehensive model may be represented in a path diagram and all factor loadings and structural relationships appear as coefficients of the path. LISREL gives a series of Goodness of Fit measures of the whole model (Jöreskog, & Sörbom, 1993; Hair, Anderson, Tatham, & Black, 1998).

1.1.3 Multidimensional Scaling (MDS)

MultiDimensional Scaling (MDS) is a procedure for fitting a set of objects or variables in a space (or plane) such that the distances between the objects correspond as close as possible to a given set of similarities or dissimilarities between the objects. Similarities can be measured directly or derived indirectly from e.g., correlation matrices (Schiffrin, Reynolds, & Young, 1981; Wilkinson, 1990). In contrast to FA no statistical distribution assumptions are necessary, even if some metric conditions must be satisfied.

1.1.4 Assumptions and Data

1.1.4.1 Assumptions.

Results of research on the impact of individual and cultural factors on adaptive performance can be used to address personnel selection, modelling and simulation, and training, resulting in development of new measurement scales designed to assess the impact of culture on teamwork and new training tools designed to turn cultural diversity into mission strengths.

1.1.4.2 Instruments.

Besides a demographic questionnaire a large number of questionnaires or measurement scales tapping different cognitive aspects as well as mental states and traits have been answered by the participants of NATO's Allied Warrior 2004 (AW04), and Allied Warrior 2005 (AW05) exercises.

Seven instruments comprised of seventeen distinct measures tapping different emotional and cognitive states and traits, formed the base for a series of data reduction and modelling analyses. The measures are named as follows: *Personal Need for Structure (PNS)* (Thompson, Naccarto, & Parker, 2001), *Personal Fear of Invalidity (PFI)* (Thompson, Naccarto, & Parker, 2001), *Need for Cognitive Structure (NCS)* (Bar-Tal, 1993), *Ability to Achieve Cognitive Structure (AACS)* (Bar-Tal, 1993), *Uncertainty Response Scale (URS)* (Greco, & Roger, 2001), *Intercultural Potential Adjustment Scale (ICAPS)*(Matsumoto, & LeRoux, 2003), *and the NEO-FFI Personality Inventory* (Costa, & McCrae, 1989). The URS has three subscales measuring *Emotional Uncertainty, Cognitive Uncertainty, and Desire for Change.* The ICAPS has five subscales measuring *Cultural Adjustment, Emotion Regulation, Need for Openness, Flexibility, and Critical Thinking.* The NEO-FFI has five subscales measuring *Neuroticism, Extroversion, Openness, Agreeableness, and Consciousness,* All instruments have been validated in other studies, and their reliabilities have been scrutinized.

2.0 ANALYSES AND RESULTS - STUDY ONE

As a first step of analyses based on data from AW04, the linear relationships between the measures by means of product moment correlations were calculated. This matrix of correlations was then used as input in explorative principal factors analyses with oblique rotation of factors. Rotation of factors results in a more even variance distribution, and in a more interpretable and simple factor structure.

From the analysis we found that 54 percent of the total variance between the manifest variables could be explained by means of three latent variables or factors. Two practicable criteria for optimisation of number of factors, Kaiser's criterion and Cattell's scree test were used (Gorsuch, 1974; Hair, Anderson, Tatham, & Black, 1998).

Figure 1 presents the three tentative groupings of variables into factors. Two of the instruments used, *'Critical Thinking', and 'Agreeableness',* had low or insignificant amount of common variance with the other measures, and were therefore excluded from further analyses.

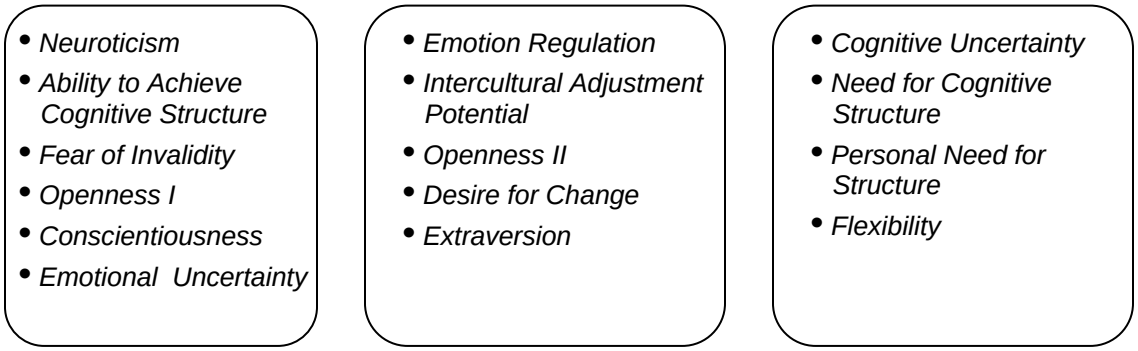

Figure 1: Groupings of variables from explorative factor analyses of the 17 measures. Fifteen out of 17 measures (88 %) are represented in the groupings or factors. Fifty-four percent of the common variance between the measures is explained by the three factors.

Our tentative interpretation of this first grouping is that the measures '*Neuroticism'*, *'Ability to Achieve Cognitive Structure'*, *'Fear of Invalidity'*, *'Openness I'*, *'Conscientiousness'*, *and 'Emotional Uncertainty'* represent a factor or latent variable named ***Emotional Stability***. Multi-dimensional analyses show that the variables '*Neuroticism'*, *'Emotional Uncertainty'*, and '*Fear of Invalidity'* represent the core of the factor.

An interpretation of the second grouping is that the measures '*Emotion Regulation'*, *'Inter-cultural 'Adjustment Potential''*, *'Openness II'*, *'Desire for Change'*, and '*Extraversion'* represent a factor named ***Adaptability.*** Dimensional analyses showed that '*Openness II'* was an outlier and that the other measures represent the central aspects of the factor.

The interpretation of the third grouping is that the measures '*Cognitive Uncertainty',' Need for Cognitive Structure'*, *'Personal Need for Structure'*, and '*Flexibility'* represent a factor named ***Need for Structure***. Multidimensional analyses indicated that '*Flexibility'* was an outlier and that the other variables represent the core of the factor.

The three factors structure from the exploratory analysis was used as a hypothesis in confirmative factor analyses ad modum LISREL. From the Goodness of Fit Statistics (GFI) of the confirmative analyses, we found that a three factors model significantly explains the co-variances between the manifest variables. The Weighted Least Squares Chi-Square equals 72.03 and has a p-value of 0.20[1]. The standardized Root Mean square Residual (RMR) equals 0.093, the Goodness of Fit Index (GFI) equal to = 0.84, and the Adjusted Goodness of Fit Index (AGFI) equal to 0.73.

In contrast to the explorative analyses, significant relationships were found between the three factors. These relationships were used in an attempt to build a causal structural model explaining the co-variances between the manifest variables by means of the interrelated factors.

When we scrutinized the factor structure of the confirmative analysis we found that the factors ***Emotional Stability*** and ***Adaptability*** correlated, and that factors ***Adaptability*** and ***Need for Structure*** correlated, respectively. This means that ***Adaptability*** relates to both ***Emotional***

[1] High p-values indicate that the factor model exhaustively explains the co-variances between the markers.

Stability and ***Need for Structure***. Accordingly, ***Adaptability*** seems to be a mediator between the other two factors.

Accordingly, we tested and confirmed a three factors structural model by means of LISREL. In this model factor ***Emotional Stability*** precedes ***Adaptability***, and ***Adaptability***, in its turn, precedes ***Need for Structure***. The final model from these analyses is presented in figure 2.

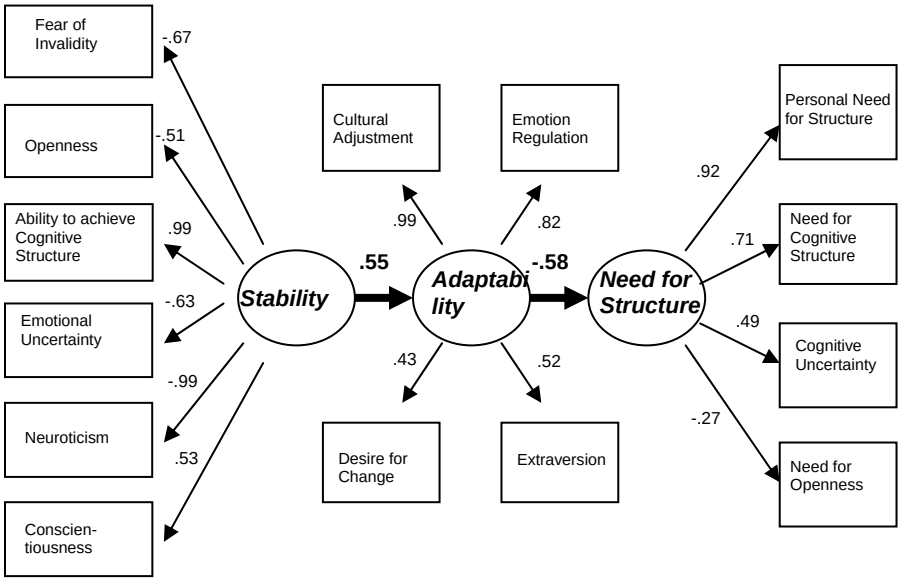

Figure 2: A structural LISREL model of the relationships between *Emotional Stability*, *Adaptability*, and *Need for Structure*. The Goodness of Fit Index (GFI) = 0.82. All effects (thick arrows) and factor loadings (thin arrows) are significant (p < .05).

As can be seen from figure 2 the three factors can be ordered in a sequence, in which ***Adaptability*** is a mediator between factors ***Stability*** and ***Need for structure***. There are no direct effects from ***Stability*** to ***Need for structure***, but a significant indirect effect. The Weighted Least Squares Chi-Square equals 80.54 and has a p-value of 0.093. The standardized Root Mean square Residual (RMR) equals 0.14, the Goodness of Fit Index (GFI) equal to = 0.82. All loadings are significant ($p < .05$). The fit of the model is acceptable.

Our interpretation of the model is that if you have a high rating in Emotional Stability i.e. low scores in fear of invalidity, neuroticism, openness, and emotional uncertainty as well as high scores in ability to achieve cognitive structure, and in conscientiousness, your rating in Adaptability will be high, i.e. you will have high scores in emotional regulation, cultural adjustment, desire for change, and extraversion. And, if your rating is high in Adaptability, you will have low scores on personal need for structure, cognitive need for structure as well as cognitive uncertainty, i.e., your rating in Need for Structure is low. Figure 3 summarizes the sequential relationships between the three factors.

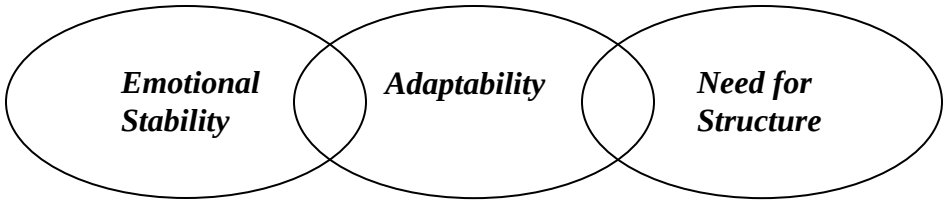

Figure 3: The sequential relationships between Emotional Stability, Adaptability, and Need for Structure.

In a second series of analyses, data from AW05 was added. In order to analyze to what extent data from AW05 was similar to the data from AW04, the correlation structures (i.e. the internal relations between the variables of the two studies, respectively) were compared. Figure 4 illustrates the correlation between the two structures.

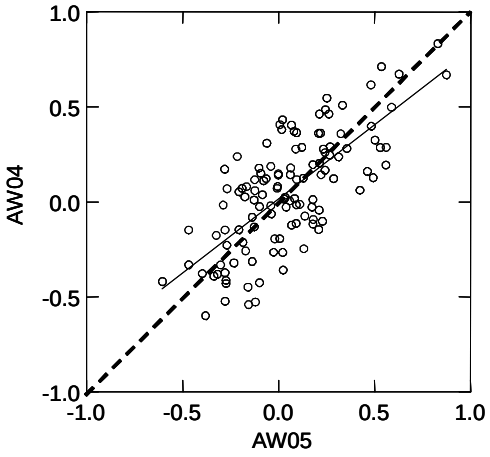

Figure 4: The relationship between the correlation structures (inter-variable correlations) from AW04 and AW05. The correlation (r) is .72, (p > .01). The common variance (r^2) is 52 percent.

The proportion of common variance between the two structures was .52. Accordingly, the similarity between the rank-orders of the correlations from AW04 and AW05 is significant (p > .01) and high. As can be seen from the figure, the variance of the AW05-distribution of correlations tends to be greater than the AW04-distribution.

Our conclusion from the finding of a close similarity between the databases from AW04 and AW05 was that the three factors model based on data from AW 04 could be tested on data aggregated from AW04 and AW05. Accordingly, the addition of the data from AW05 represents a test of the validity of the model in an extended sample. The number of subjects from the two exercises was 155.

Figure 5 presents the three factors structural model based on data from AW04 **and** AW05. The Weighted Least Squares Chi-Square equals 85.11 and has a p-value of 0.03. The standardized Root Mean square Residual (RMR) equals 0.10, the Goodness of Fit Index (GFI) equal to = 0.85. All loadings are significant ($p < .05$).

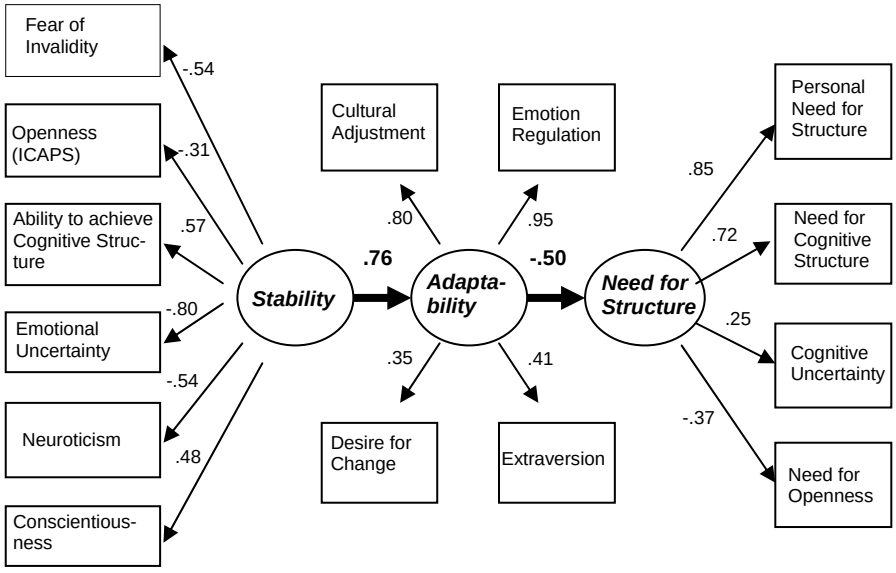

Figure 5: A structural LISREL model of the relationships between *Emotional Stability*, *Adaptability*, and *Need for Structure*. The Goodness of Fit Index (GFI) = 0.85. All effects (thick arrows) and factor loadings (thin arrows) are significant (p < .05).

Our conclusion is that the fit of the model is acceptable, and that the data from AW05 support and validate the model based on data from AW04.

From the explorative as well as from the confirmative analyses we have found a three factors model in which the factors are ordered sequentially (***Stability*** affects ***Adaptability***, and ***Adaptability***, in its turn, affects ***Need for Structure***). However, from discussions within the research group an alternative solution was suggested. In this model ***Emotional Stability*** will directly affect ***Need for Structure*** as well as ***Adaptability***.

From LISREL-analyses we found that the fit of this model was as good as the fit of the original model. The Weighted Least Squares Chi-Square equals 82.89 and has a p-value of 0.04. The standardized Root Mean square Residual (RMR) equals 0.11, the Goodness of Fit Index (GFI) equal to = 0.85. All loadings are significant ($p < .05$). Figure 6 presents the model in which ***Emotional Stability*** directly affects ***Adaptability*** and ***Need for Structure***.

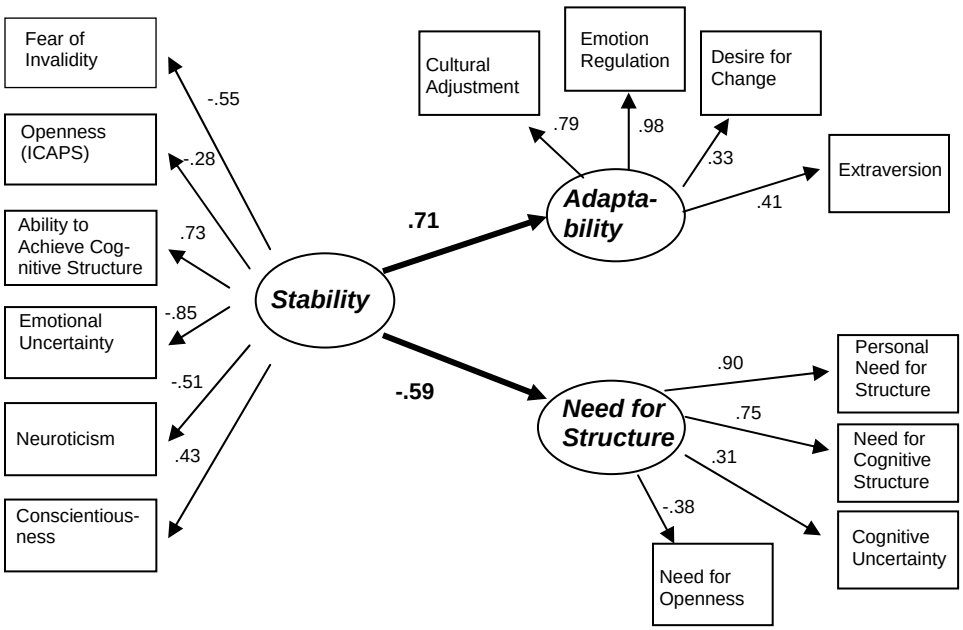

Figure 6: A structural LISREL model representing the direct effects of *Emotional Stability* on *Adaptability*, and *Need for Structure*, respectively. The Goodness of Fit Index (GFI) = 0.85. All effects (thick arrows) and factor loadings (thin arrows) are significant (p < .05).

Accordingly, we have two models of equal fit. The models explain the same amount of common variance, they confirm the structures to the same extent, and they can both be generalized to the population of subjects. To determine which of the models that is to be preferred is both a theoretical and practical matter. Obviously, both can be used as complementary models.

The models of figures 5 and 6 are based on 14 markers. We have also tested the fit of the model when using two of the main markers of each factor (i.e. altogether six measures). By using the main markers we are optimizing the relationship between the proportion of variance explained and the number of measures used. Figure 7 presents this optimized model.

The Weighted Least Squares Chi-Square of the optimized model equals 4.09 and has a p-value of 0.76. The standardized root mean square residual (RMR) equals 0.04, the Goodness of Fit Index (GFI) equal to = 0.98. All loadings and weights are significant (p < .01). The fit of the model is almost perfect.

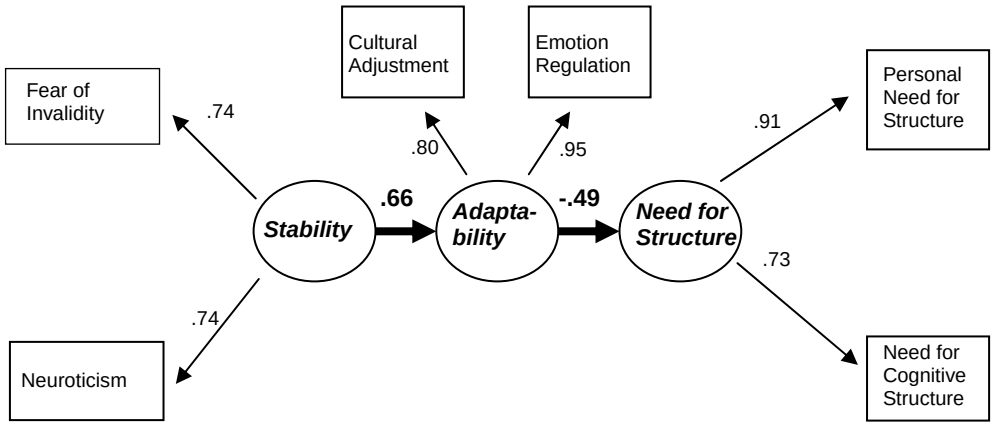

Figure 7: A structural LISREL model of the relationships between *Emotional Stability*, *Adaptability*, and *Need for Structure*. The model is based on six main manifest variables. The Goodness of Fit Index (GFI) = 0.98. All effects (thick arrows) and factor loadings (thin arrows) are significant (p < .01).

The alternative model (in which *Emotional Stability* directly affects *Need for Structure* as well as *Adaptability*) has also been analyzed by using six main markers. Figure 8 presents the alternative and optimized model.

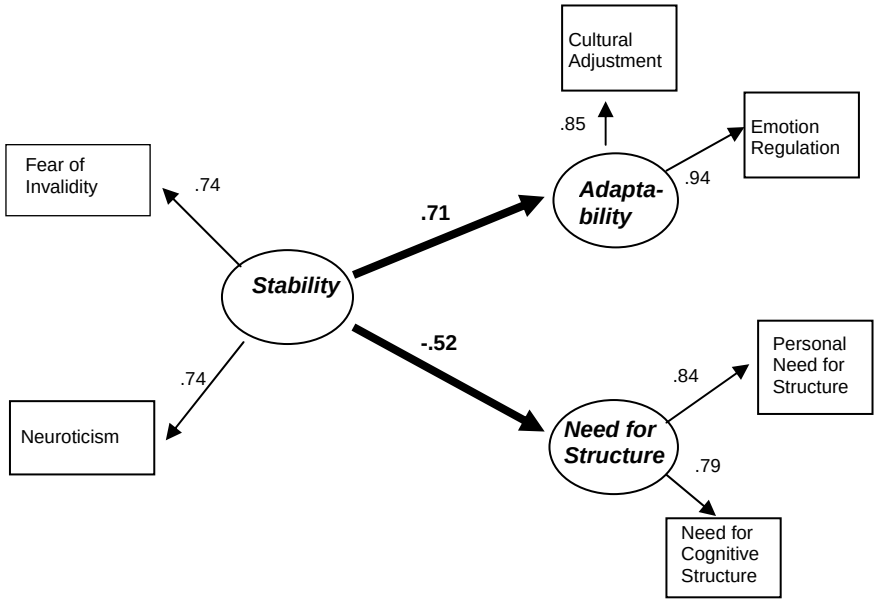

Figure 8: A structural LISREL model representing the direct effects of *Emotional Stability* on *Adaptability*, and *Need for Structure*, respectively. The model is based on six main manifest variables. The Goodness of Fit Index (GFI) = 0.97. All effects (thick arrows) and factor loadings (thin arrows) are significant (p < .01).

The Weighted Least Squares Chi-Square of the alternative and optimized model equals 7.02 and has a p-value of 0.43. The standardized root mean square residual (RMR) equals 0.05, the

Goodness of Fit Index (GFI) equal to = 0.97. All loadings and weights are significant ($p < .01$). The fit of the alternative optimized model is almost perfect.

When comparing the factors of the large models represented by 14 markers with the factors of the small models represented by six markers we found that the correlations between the stability factors was .89, the adaptability factors .76, and the need for structure factors .90. Accordingly, the common variances for the factors were 79, 58, and 81 percent, respectively.

As illustrated in figure 9, the structural model can be visualized in a Euclidean space, of which the three dimensions represent the factors ***Emotional Stability, Adaptability***, and ***Need for Structure***, respectively.

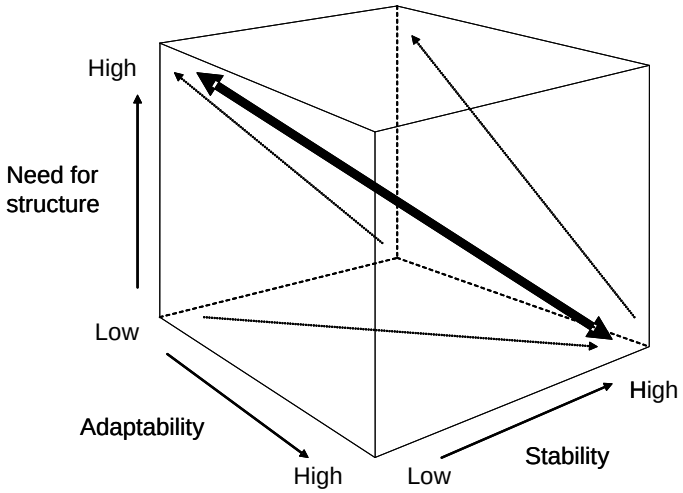

Figure 9: A representation of the structural model in a Euclidean space. The three dimensions indicate the factors *Stability*, *Adaptability*, and *Need for Structure*. The double headed arrow illustrates a goodness of fit continuum.

The vector or arrow from the lower right to the upper left corner of the cube, illustrates a continuum from high ***Stability***, high ***Adaptability***, and low ***Need for Structure*** to low ***Stability***, low ***Adaptability***, and high ***Need for Structure***. We consider the integrated continuum to indicate a 'personality goodness of fit index' of importance for prediction of operational performance.

3.0 DISCUSSION – STUDY ONE

By means of factor analyses, multidimensional scaling, and modeling ad modum LISREL, 17 personality measures have been reduced to models of three interrelated latent variables or factors.

From the explorative analyses we hypothesized a three factors model as an optimal solution. From these analyses we found that 82 percent of the variables have an acceptable communality (i.e. significant co-variances with the other measures) for confirmative analyses. From the con-

firmative analyses we found that a model of three interrelated factors significantly explains the co-variances between the manifest variables.

From the initial structural model analyses (data from AW04) we confirmed that the co-variances between the variables were thoroughly explained by a sequential relation between the factors ***Emotional Stability***, ***Adaptability***, and ***Need for Structure***. We also found that the structural model can be generalized to the population.

An interpretation of the model is that if you have a high rating in ***Emotional Stability*** i.e. low scores in fear of invalidity, neuroticism, openness, and emotional uncertainty as well as high scores in ability to achieve cognitive structure, and in conscientiousness, your rating in ***Adaptability*** will be high, i.e. you will have high scores in emotional regulation, cultural adjustment, desire for change, and extraversion. And, if your rating is high in ***Adaptability***, you will have low scores on personal need for structure, cognitive need for structure as well as cognitive uncertainty, i.e., your rating in ***Need for Structure*** is low.

In a second series of analyses data from AW04 **and** AW05 were used. Our conclusion from these analyses is that the data from AW05 support and validate the model based on data from AW04.

From discussions within the research group an alternative solution was suggested. In this model ***Emotional Stability*** directly affects ***Need for Structure*** and ***Adaptability***. Confirmative analyses of the alternative model showed that this structural model has the same fit as the sequential.

Accordingly, we have two structural models of equal and acceptable fit. The structural models explain the same amount of common variance between the measures, they confirm the structures to the same extent, and they can both be generalized to the population of subjects. To determine which of the models that is to be preferred is both a theoretical and practical matter. Obviously, both can be used as complementary models.

We have tested the fit of the models when using two of the main markers of each factor (i.e. in all six measures). From these analyses we found an almost perfect fit of the sequential as well as the alternative model. Accordingly, six of the measures used can represent the models adequately.

Our conclusion is that the subjects can be reliably ordered or classified with respect to the three, factors by means of six measures. To use these six measures is an economic way of getting information representing all of the measures.

When scrutinizing the proportion of variance accounted for by the factors we found that ***Emotional Stability*** explains more variance than the other two factors. This is, of course, a reflection of the psychological content of the measures analysed, but it also reflects the prominence of the stability concept. The aspects representing emotional stability are related to operator performance and, since long, of central importance in e.g. selection of military pilots and conscripts.

Unlike many other situations of measurement, each measure has a proved reliability and validity, and most of them are, in themselves, personality factors. In fact, four trait dimensions of the ‘Big Five’ (Emotional Stability, Conscientiousness, Extraversion, and Openness to Experience) are represented in our analyses. This ‘inborn’ part of reliability and validity gives additional strength to the quality of the indices for the three factors and the structural models found. From a statistical point of view, ***Emotional Stability, Adaptability***, and ***Need for Structure*** are second order fac-

tors (i.e. factors of factors). The fact of the matter that the factors have specific and logical relations to each other in the model strengthens further their construct validity.

Digman (1997) has performed as series of confirmative factor analyses of the 'Big Five' dimensions (Agreeableness, Conscientiousness, Emotional Stability, Extraversion, and Intellect or Openness to Experience). In all analyses a two factors solution was confirmed. As can be seen from figure 10, the trait dimensions Agreeableness, Conscientiousness, and Emotional Stability were markers of the first factor, called **α**, and the dimensions Extraversion, and Intellect were markers for the second factor called **β**. As can also be seen, the factor ***Emotional Stability*** of our analyses is comparable to Digman's factor **α,** and our factor ***Adaptability*** is close to his **β**-factor. Digman considers his two factors to be orthogonal or un-correlated. However, in our re-analyses of Digman's data we found factor **α** and factor **β** to be correlated in the same way as ***Emotional Stability*** and ***Adaptability*** are in our models.

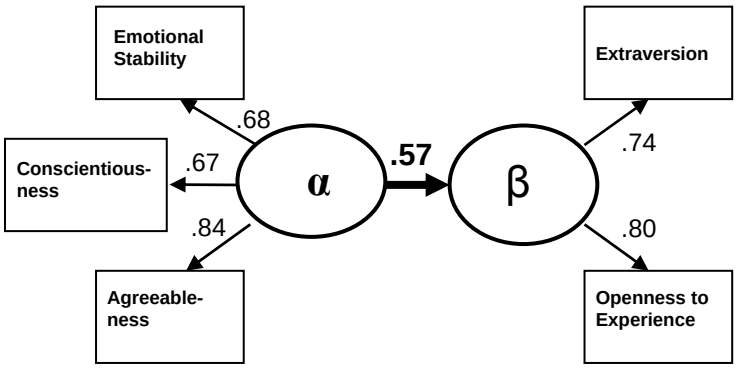

Figure 10: A structural LISREL model representing the direct effects of α (*Emotional Stability)* on β (*Adaptability)*. The P-value is .74, RMSEA is .00, and the CFI is .99. All effects (thick arrows) and factor loadings (thin arrows) are significant (p < .01).

Accordingly, from our re-analyses of the 'Big Five' dimensions, we can conclude that, from a statistical point of view, the 'Big Five' dimensions can be thoroughly explained in terms of two factors (close to ours ***Emotional Stability*** and ***Adaptability***) and their relation.

4.0 INTRODUCTION - STUDY TWO

In these analyses of data from NATO's Allied Warrior 2004 (AW04), and Allied Warrior 2005 (AW05) exercises (Study One) no data on performance aspects such as mental workload, situational awareness, and operational performance were available. Accordingly, the assumed causal relationships between Stability- and Adaptability measures and aspects of Performance could not be tested in Svensson et al. (2005, 2008).

In new studies Stokes, Schneider and Lyons (2008) have analyzed the effects of dispositional traits on adaptive performance. In Stokes et al. (2008) different theoretical models on the effects of traits and states on performance combine into a unified model. The model or adaptive profile developed by Svensson et al. (2008) was used as a starting point, to which measures of *Stress-*

coping appraisals, measures of *Self-efficacy*, and measures of *Adaptive Performance* were added. Figure 11 presents their verified and final model.

An interpretation of the model of Stokes et al. (2008) is that if you have a high Emotional and Cognitive Adaptability you will cope better with Cognitive and Emotional Stress, and a high Coping Ability will, in its turn increase your Self-efficacy. And finally, a high Self-efficacy prepares the ground for a high Adaptive Performance.

The results from the studies of Stokes et al. (2008) support and give refinement to the model or adaptive profile of Svensson et al. (2008) and a confirmation that the profile predicts adaptive performance. The results also establish the predictive validity of the mediating measures of Stress Coping appraisal and of Self-efficacy.

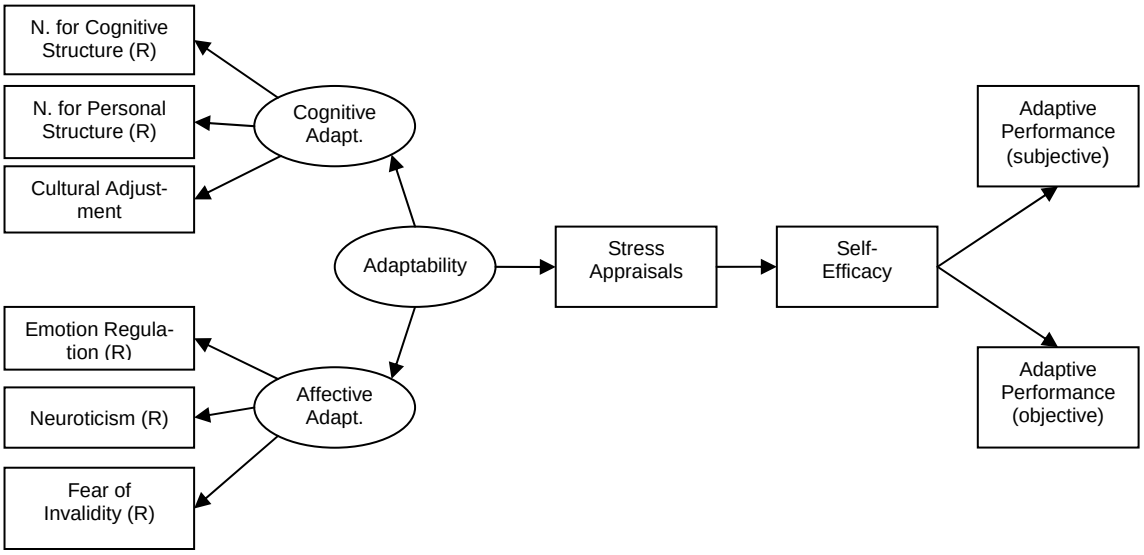

Figure 11: The Hypothesized complete Model of Adaptive Performance (Stokes et al., 2008)

4.1 Validation of the complete model

Information load, situational awareness and performance are central aspects in command and control as in many other situations. If we can estimate and validate the effects on these performance-related criterion variables from the personality profile, and coping processes in other situations and with other samples of subjects, we will be able to broaden the applicability of the complete model developed by Stokes et al. (2008).

The complete model of Stokes et al. (2008) has been verified in a team-based laboratory task with university students of different cultures as subject. It is of importance to verify the model in a broader perspective. Can the model be generalized to populations of tasks and subjects of relevance to operational settings? In our effort to validate the model we will include variance not just from individuals and teams, but also from situations or tasks. Accordingly, to the *inter-individual* variance we add *inter-task* variance. To add and use variance in performance from different tasks is a less common practice in experimental designs. However, we consider this type of variance of

specific importance with respect to the diversity of requirements on leaders' and teams' adaptive performance in complex command and control environments. To cite the steering program for the task group *Leader and Team Adaptability in Multinational Coalitions (HFM 138),* a "complicated assemblage of coalition partners will be required to perform as a team in complex environments that place high demands on the command and control of forces. These complex environments make adaptive performance more critical than ever, yet the presence of adaptable leaders and teams continues to be elusive"(Pierce, 2002).

5.0 METHOD – STUDY TWO

5.1 Instruments

The personality measures used were the same as in Svensson et al. (2005, 2008) and in Stokes et al. (2008): Need for Cognitive Structure (NCS), Personal Need for Structure (PNS), Cultural Adjustment (CA), Emotion Regulation (ER), Neuroticism (N), and Fear of Invalidity (PFI). Detailed information of the scales is presented in Stokes et al. (2008).

In addition to these measures *Stress Appraisals* and *Self-efficacy* were used as mediating factors between personality aspects and the performance measures.

Stress Appraisals concern the potential threat of a situation in relation to the individual's goals, values, and beliefs and the resources for responding to the demands of the situation. Threat appraisals occur when individuals believe their resources, such as skills and abilities, are disproportionate to the demands of the situation. Challenge appraisals occur when individuals construe their resources as proportionate to or exceeding situational demands. The stress appraisals measure presents a continuum ranging from perceiving the situation/task as a challenge to perceiving it as a threat (Stokes et al., 2008; Svensson, Angelborg-Thanderz & Sjöberg, 1993).

Self-efficacy concerns the belief that one is capable of performing in a certain manner to attain certain goals or execute the courses of actions required to manage prospective situations. The participants rate their confidence in their being able to achieve each of the behaviours as they pertain to the task. Self-efficacy has been identified as a predictor of performance (Stokes et al., 2008).

Objective and subjective aspects of *Task Performance* were collected. The subjects and instructors rated individual and team performance. Individual, team, and logged performance were combined into a general performance measure. As the validation study includes different subject groups and tasks, the performance measures were standardized within each group. By means of this procedure the co-variance of the performance measures with the other measures could be estimated over subject of the different groups.

5.2 Participants and tasks

In the validation of the model we included not only individuals and teams representing a specific category, but also different groups of subjects and teams representing different situations and tasks. A total of 44 persons, divided into teams of three or five, participated in the study. Five teams were composed of students, seven teams were analysts from the Swedish Defence Research Agency (FOI), and ten teams were active fighter pilots of the Swedish Air Force. As a consequence of the different professions of the groups, the tasks performed were different. The students and the analysts worked in teams of three and were tasked to solve eight logical problems during 60 minutes, two primary tasks and six secondary tasks. The two primary tasks were logic, matrix

based problems which required the participants to analyze information and figure out how different aspects of the problem were interrelated. They were complex and time consuming and the participants had 35 minutes to solve the first one and 25 minutes to solve the second one. The tasks were distributed in sequence. The secondary tasks were spatial-logic tasks (e.g. a number of coins are arranged in the form of a triangle and the task is move the minimum number of coins to create a scare). The secondary tasks were distributed to the teams through out the experiment at specific times (i.e. 10, 20, 30, 35, 45 and 50 minutes into the experiment). The secondary tasks were less complex but needed to be solved in parallel with the primary tasks and within ten minutes from the distribution of the task. The teams' goal was to solve as many problems as possible during 60 minutes and gain as many points as possible. Each problem could generate different scores depending on the level of difficulty and time available. The primary tasks could generate 0-20 points each and the secondary tasks were worth either 0-5 or 0-10 points each. All tasks were clearly labelled with time-limits and maximal scores. The teams had to solve the tasks together but could divide the work between them in the way they found most effective (i.e. to generate as many points as possible). To create a dynamic and somewhat stressful situation the participants also had to fill out status reports every 10 minutes rating their progress in the experiment.

The pilots worked in teams of five (four JAS39 pilots and one ground controller) during a Flight Lead Upgrade Course at the Swedish Air Force Combat Simulation Centre (FLSC). The FLSC is a simulator facility designed to train air combat in many vs. many situations. The facility contains eight linked fighter aircraft cockpits and four ground controller stations. The Flight Lead Upgrade Course is part of the training that flight lieutenants receive in order to be qualified to lead a fourship of fighters. The pilots attending the course are already experienced military pilots with approximately 1000 flight hours of military flight training. During the course emphasis is put on planning, leadership and team management skills. Their task during the course was to plan and execute a full mission cycle (planning, execution and debriefing) in a Peace Support Operations scenario. The full mission cycle in this case required approximately eight hours of work. During planning and mission execution the pilots are faced with a number of challenges and decisions delivered by the course instructors in order to train the pilots' team management skills. At the end of each mission cycle the course instructors provided a number of performance ratings. They rated the performance of each pilot and each team. They also rated the quality of the teams' cooperation and to what extent the teams could follow the plan they had made. All pilots rated theirs own performance, their team members' individual performance and the performance of the entire team. All ratings were done on a scale from 1 to 7 where 1 = extremely poor and 7 = extremely good.

5.3 Statistical Procedures

Data reduction and structural modelling were performed by means of LISREL ((Jöreskog & Sörbom, 1993).

6.0 ANALYSES AND RESULTS – STUDY TWO

6.1 Datasets

Two datasets were developed: one in which data from each subject was used once (dataset A) and one in which data from the pilots' group was used repeatedly (dataset B). Data for the students'

and analysts' groups are the same in the two datasets. Eighteen subjects from the students' and analysts' groups, respectively, and eight from the pilots' group participated.

In dataset A, each subject represents one data-row, and when subjects have participated in different group constellations (which was the case for the pilots) the means of the performance measures over constellations were used. The number of cases of set A was 44 (18+18+8).

In set B, data from each specific team constellation of the 8 pilots was used as a case, which formed 30 different cases with respect to the performance measures. The personality measures of the pilots were used repeatedly. The number of cases of set B was 66 (18+18+30).

The datasets are different with respect to the variance sources used for estimation of co-variances or correlations between the variables: The co-variances from dataset A are based on inter-individual variance, and the co-variances of set B are based on inter-individual variance as well as intra-individual variance of the pilots' group with respect to the performance measures. From a logical point of view, it is reasonable to use the personality measures repeatedly inasmuch as they represent stable traits as compared to the more state-like performance measures. As noted above, the performance measures were standardized (M = 0, SD = 1.0) for each of the subjects groups.

To include intra-individual or intra-case variance can cause dependency between measures, which, from, a puristic statistical point of view, is inappropriate. However, ample evidence from a series of studies shows that the detrimental effects on the statistical outcomes are minor and conservative (cf. Castor, 2009). The presence here of possible effects on the correlation structure will be analyzed.

In order to analyze to what extent dataset B was similar to the dataset A, the correlation structures (i.e. the internal relations between the variables of the two datasets, respectively) were compared. Figure 12 illustrates the correlation between the two structures. As can be seen there is a significant linear relationship between the two correlation structure ($r = .983$, $p < .001$), and the common variance between the structures is 97 percent.

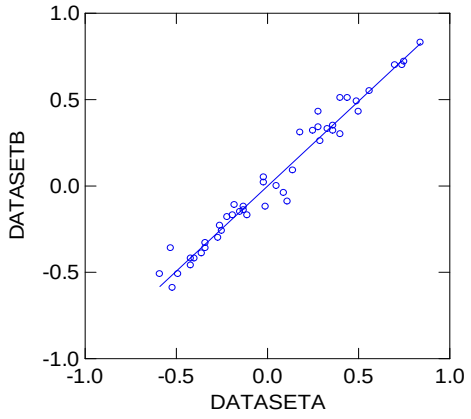

Figure 12: The relationship between the correlation structures (inter-variable corre-lations) from dataset A and dataset B. The correlation (r) is .983, (p > .001). The common variance (R^2) is 97 percent.

Accordingly, the effects of adding the repeated measures of the pilots in dataset B do not significantly change the correlation structure, and the effects of dependencies between measures are insignificant.

Differences between the subjects groups are expected to affect the correlation structures. When comparing the structure of the original dataset B with the corresponding structure corrected for groups, by means of partial correlation analyses, a correlation of .940 ($p < .001$), and a common variance of 88 percent were found. Accordingly, about 10 percent of the variance is influenced by aspects related to the subject groups. Inspections of the structures indicate that differences in the performance related aspects of the groups are the main cause[2].

6.2 Correlation Analyses

Correlation analyses of dataset A was our starting point. In confirmative factor analyses the factors *Cognitive adaptability* and *Affective adaptability* of Stokes' model in figure 1 were verified. However, the marker Cultural adjustment of *Cognitive adaptability* could, as well be a marker of the factor *Affective adaptability*.

In the factor analyses we also found that the performance measures used in our validation study (Individual performance, Team performance, and Actual performance) formed a performance factor called *General performance*.

From the factor inter-correlation structure, we found no significant relationship between the measures Stress appraisal and Self-efficacy. Furthermore, the Stress appraisal measure correlates negatively (as expected from the model in figure 11), with Cognitive adaptability, but positively with the Performance factor. For these inconsistency reasons, the stress appraisal measure was excluded in the further model analyses.

Figure 13 (next page) presents the final structural model based on dataset A. As noted, the stress appraisal measure is excluded, and the performance measures are different as compared to those of Stokes' model in figure 1. However, except for the stress appraisal measure, the structural model is identical to the model in figure 1. The general fit of the model is high with $\chi^2 = 31.76$; df = 33, p =.53. RMSEA = .001, RMR = .092, GFI = .87, AGFI = .78, and CFI = .98.

As can be seen from the model, the 6 personality measures form two factors: *Cognitive adaptability* and *Affective adaptability*, which together form a second order factor called Adaptability. The factor loadings indicate that Affective adaptability is the main marker of the Adaptability factor. This was also found by Stokes et al. (2008), and is in accordance with the models of Svensson et al. (2005, 2008).

[2] When comparing differences in means between the groups, tendencies showed that the pilots' group had a higher adaptability- and self-efficacy level. This is to be expected because military pilots are selected by means of these traits.

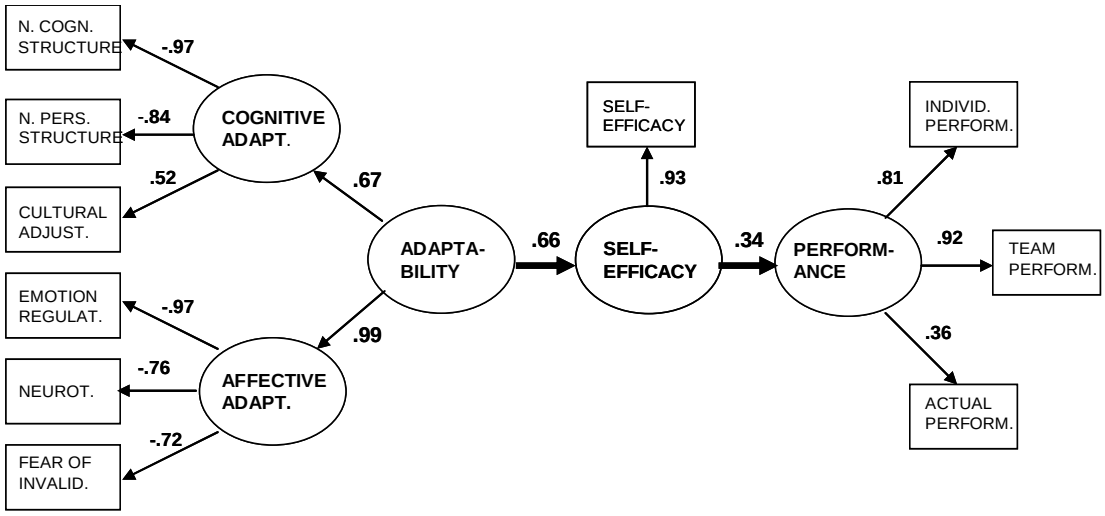

Figure 13: A structural LISREL model of the relationships between Cognitive Adaptability, Affective Adaptability, General Adaptability, Self-efficacy and General Performance. The model is based on database A (n=44). χ^2 = 31.76; df = 33, p =.53. RMSEA = .001, RMR = .092, GFI = .87, AGFI = .78, and CFI = .98. All effects (thick arrows) and factor loadings (thin arrows) are significant (p < .05).

Model analyses of the effect of Adaptability on Performance shows no significant direct effect. However, Adaptability has an effect on Self-efficacy, which, in its turn, affects Performance. Accordingly, Self-efficacy acts as a mediator between Adaptability and Performance. This finding is also in accordance with Stokes' model.

As noted, the Performance factor of our study is different from Stokes', and represents the common variance between rated individual performance, team performance, and actual performance. As can be seen, the lion's share of the factor variance is represented by the individual- and team performance measures.

Figure 14 (next page) presents the final structural model based on dataset B including repeated measures from the pilots' group. The same conclusions as for the model based on the dataset A can be drawn. As can be seen from a comparison, the model of figure 4 is more pronounced with generally higher factor loadings and effects. The general fit of the model is also very high with $\chi 2$ = 29.52; df = 29, p =.39. RMSEA = .029, RMR = .072, GFI = .92, AGFI = .84, and CFI = .99.

From the effects of *Adaptability* on *Self-efficacy*, and *Self-efficacy* on *Performance*, we find that 53 percent of the variance in Self-efficacy is explained by the variance in Adaptability, and that 23 percent of the variance in Performance is explained by the variance in Self-efficacy. If the Performance factor is represented by the individual- and team performance measures, Self-efficacy explains 29 percent of the variance in Performance.

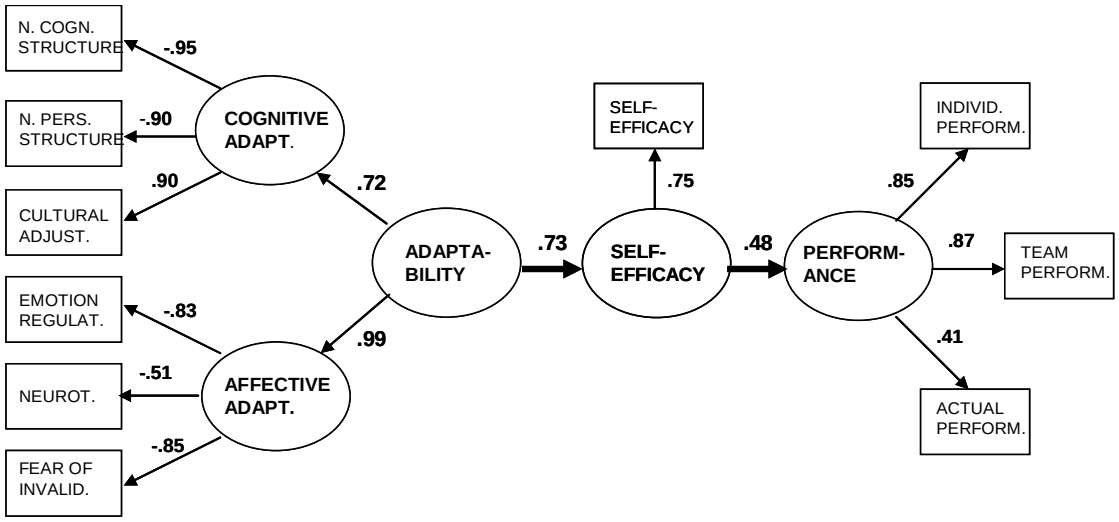

Figure 14: A structural LISREL model of the relationships between Cognitive Adaptability, Affective Adaptability, General Adaptability, Self-efficacy and General Performance. The model is based on database B (n=66). χ^2 = 29.52; df = 29, p =.39. RMSEA = .029, RMR = .072, GFI = .92, AGFI = .84, and CFI = .99. All effects (thick arrows) and factor loadings (thin arrows) are significant (p < .01).

The mediating role of Self-efficacy is even more pronounced in this model. The indirect effect of Adaptability on Performance, and mediated by Self-efficacy, is .35 and significant ($p < .001$).

In conclusion, the results validate the model proposed by Stokes et al. (2008), and the inclusion of between groups- and between tasks variance increase the ability to generalize to other subjects and situations.

7.0 DISCUSSION – STUDY TWO

In new studies on performance prediction Stokes, Schneider and Lyons (2008) analyzed the effects of dispositional traits on adaptive performance. In Stokes et al. (2008) different theoretical models on the effects of traits and states on performance combine into a unified model (figure 11). The model or adaptive profile developed by Svensson et al. (2005, 2008) was used as a starting point to which measures of *Stress-coping*, *Self-efficacy*, and of *Adaptive Performance* were added. An interpretation of the model of Stokes et al. (2008) is that if you have a high emotional and cognitive stability you will cope better with cognitive and emotional stress, and a high coping ability will, in its turn increase your Self-efficacy. And finally, a high Self-efficacy prepares the ground for a high Adaptive Performance.

Accordingly, the results from the studies of Stokes et al. (2008) support the model or adaptive profile of Svensson et al. (2005, 2008), and confirm that the profile predicts adaptive performance. The results of Stokes also establish the predictive validity of the mediating measures of *Stress-coping* appraisal and *Self-efficacy*.

The aims of Study Two were to validate Stokes et al. (2008) model, and to increase the ability to generalize the model to other groups of subjects and situations. The general finding and conclu-

sion is that the model is valid, and applicable in different subject- and task populations. However, the mediating effect of *Stress-coping* was not found in our validation, and *Self-efficacy* was the fundamental mediating factor integrating personality- and performance aspects. Another interesting conclusion is that the predictive power of the adaptive profile on performance is much higher (29 %) in this study than usually found in other studies (Mischel, 1968; Sjöberg et al., 1997).

8.0 CONCLUSION

What are the implications of the structural models for leader and team adaptability? ***Emotional Stability*** and ***Adaptability*** are fundamental aspects in selection of personnel working under stressful conditions with high stakes and risks. With high emotional stability your cognitive performance (information handling and decision making) can stand high stress levels longer without deterioration. With high ability to adapt you are better at handling complex and ambiguous information and situations. We have in other modeling studies (Svensson, Angelborg-Thanderz, & Sjöberg, 1993) found that emotional cooping processes will increase and interfere with problem solving cooping processes when the challenge (the combination of risk- and complexity aspects) of a task increases. Sooner or later emotional cooping dominates with deteriorated decision making as a consequence. Emotional stability counteracts and delays emotional cooping. There are similarities between the effects of emotional stability and the effects of training – both delay emotional cooping and support problem solving cooping processes. It is not for nothing that emotional stability and intense training since long form corner stones for effective military operations.

Accordingly, there is strong evidence of relationships between stress tolerance or emotional stability and aspects of cognitive performance under high information load and psychological stress. Consequently, the factors of the models have a predictive potential in the recruitment of personnel to e.g. exposed or critical positions in C^2-systems. The high reliability of the factors of the models increases the predictive power further, and, accordingly, the measures can be applied even in situations where only a few are accessible for a specific position.

Even if the validity and reliability of our factors are manifest and high as compared to specific and singular personality measures, the predictive power of the measures or factors is not perfect - there is no one to one relationship between the personality measures and cognitive performance under stress and strain. On the other hand, from a statistical point of view, the probabilities of successful performance increase as a function of increased emotional stability and adaptability. It is also of importance to notice that experience in and training of specific situations counteract interfering effects of personality factors. Personality traits can, partly, represent states, and, accordingly, change as a function of situation, training, and surrounding factors.

In the AW 2004 and AW 2005 no performance aspects were measured. Accordingly, we were not able to relate personality factors to performance criteria, and, to that end, Study Two was performed. Stokes et al. model presents strong relationships between Stability, Stress-coping, Self-efficacy and performance.

Our general findings are that Stokes et al. model is valid. We also found that it is applicable in different subject- and task populations. Self-efficacy was found to be the fundamental mediating factor integrating personality- and performance aspects. Furthermore, the predictive power of the adaptive profile on performance is higher in this study than usually found in other studies.

In a series of studies on modelling of human performance, we have, in the same way, found that effects often are (have to be) mediated by intermediate or proximal concepts. For example, the effects of information load and mental workload on performance are mediated by the concept situational awareness, and without this mediator the relations between workload and performance are hidden or less pronounced (Svensson, Angelborg-Thanderz, & Wilson, 1999; Svensson, & Wilson, 2002). This type of structures can often be represented by simplex models (Castor, 2009). The importance of proximal mediators has also been emphasized by Sjöberg (2008).

As noted there has been a lot of criticism of using personality measures in selection because of stated low predictive power, and, indeed, the relationships found between personality measures and aspects of performance such as e.g. leadership have generally been weak. However, late meta-analyses (Judge, Bono, Ilies, & Gerhardt, 2002; Zaccaro, 2007; Sjöberg, 2008) show that personality measures, to a substantial part, can predict leaders' performance in operational settings. Judge et al. (2002) found that the five-factor model had a multiple correlation of .48 (i.e. a common variance of 23 percent) with leadership, which strongly supports the trait perspective for prediction. Interestingly, the predictive power of the adaptive profile of Stokes et al. model reflects the findings and conclusions of Judge et al. (2002) very well. Zaccaro (2007) states that increased conceptual, methodological, and statistical sophistication will make the trait perspective to better account for situational variance in leadership behaviour. He also argues that combinations of traits and attributes, instead of single trait measures, are more likely to predict leadership. The optimal combination of traits into stability- and adaptability concepts or factors in our models, we believe, is the main explanation to their high predictive power.

During the last years, other aspects or concepts, besides the Big-Five dimensions, have been proposed as important predictors of performance related aspects. In a series of 11 studies and with more that 2000 subjects, a new instrument for selection has been developed at Stockholm School of Economics (Sjöberg, 2008). The instrument is based on the Big-Five-tradition but dimensions measuring emotional intelligence are added. As compared to the general Big-Five, the questions are more focused and emotionally close to the subject. An important aspect is that the instrument includes correction for social desirability. The results of validation studies are promising, and the predictive power of the new instrument (called Big-Five Plus) is remarkably high and ranging from .51 to .67.

We conclude that by mean of the personality-factors found and validated, the development of reliable and practicable measures of basic aspects predicting performance and co-operative ability of personnel working in coalition has been brought a step further.

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